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SATELLITE JOURNAL

Journal of the Radio Amateur Space Program

March-April 1985, No. 2

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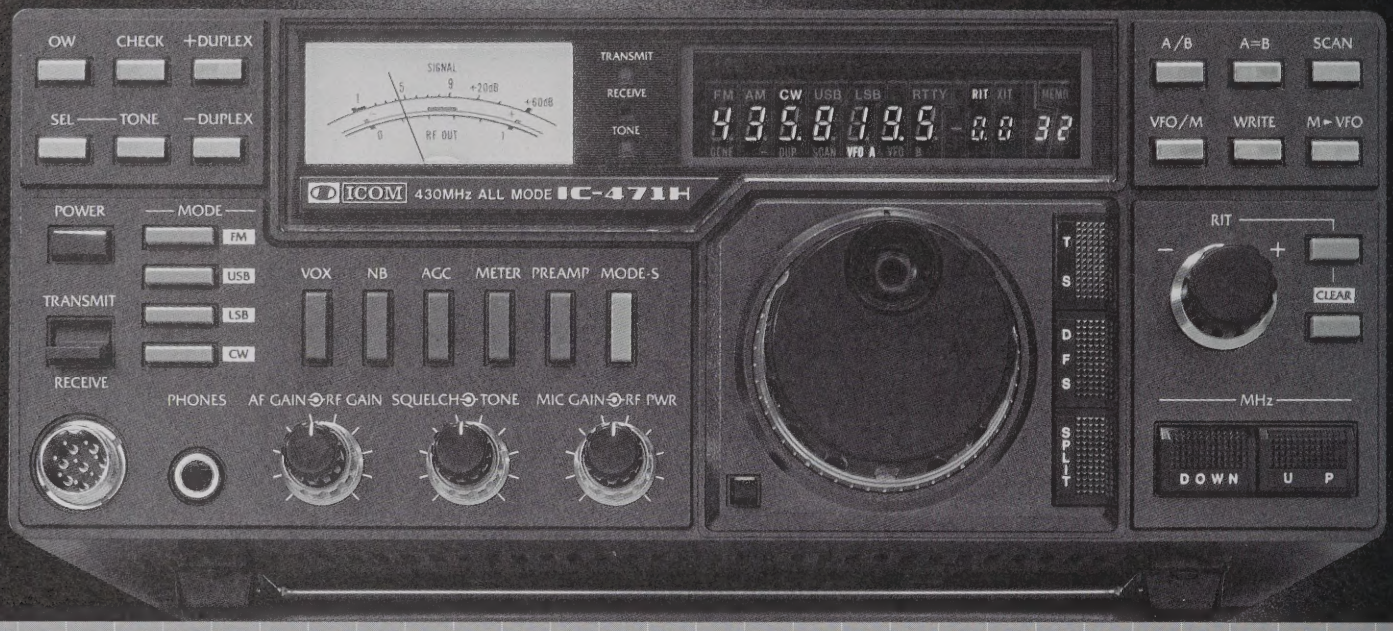

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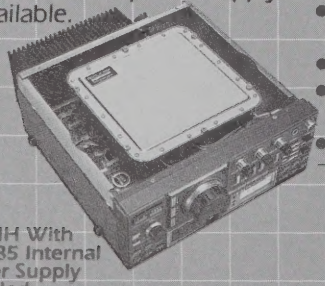

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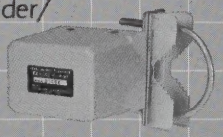

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On the cover: The prime focus of the 150-ft dish antenna of SRI International sports a pair of 2-meter dipoles and a horn for 400 MHz. The antenna, located in Menlo Park, California, was instrumental in the 1983 rescue of the temporarily deafened UoSAT-OSCAR-9 spacecraft.

PERSPECTIVE

In Russian parlance, a troika consists of three horses, usually hitched to a carriage or wagon and all pulling in the same direction. More recently, the word has been used to describe a council of three leaders, all of whom are required to pull the ship of state in the same direction at the same time.

The troika, as a form of leadership at the top levels of Soviet government, has not been successful. One person usually emerges from among the three to take hold of the reins of government. However, leadership by council has been somewhat more successful in other parts of the world, where conformity of opinion is not a prerequisite for membership to the governing body. And despite jokes to the contrary, a committee can indeed take a constructive rather than obstructive role in the affairs of state or, for that matter, the affairs of an organization of any size.

If all members of a committee needn't be of like mind to be productive, what is the glue that holds the committee together and the catalyst that prompts it towards action? The glue is commitment and the catalyst, a clearly defined goal.

Every few years in amateur radio, a new technology or mode of operation comes along that requires hams to band together into groups to solve mutual problems. The American Radio Relay League was the result of just such a need and repeater councils are a more recent example of the desirability of concerted efforts by individuals within the framework of an organization.

A new technology has forced the amateur community to again think about the need for formal organization. Packet radio, once the plaything of self-described "bearded experimenters," is now a thriving branch of our varied avocation and one that promises to bring us many benefits. One of the first will be PACSAT, an orbiting digital mailbox that will store and forward messages to radio amateurs all over the world. Hams in sparsely populated areas will have no difficulty sending a message to the satellite as it makes one of several passes each day. However, hams living in heavily populated areas will have a problem. Everyone will want to send and receive messages during convenient times and many may not have the equipment or know-how to set up a fully automatic station.

A practical solution to the problem appears to be the gateway station. A radio amateur would prepare a message for a distant friend and send it to a regional gateway station for storage and subsequent transmittal to PACSAT during one of its several daily passes. It will be able to send messages in an orderly, serial fashion, one after the other, allowing everyone's message to be received and stored without interference. The gateway station makes eminent good sense but it does pose some problems.

Like all forms of communication, packet radio requires a set of protocols that extend beyond merely the equipment, software, and communication conventions. In order for people to communicate via packet, especially over very long distances, the amateur community must come to grips with not only what networking scheme to use, but also who will pay for it, who will install it, and who will maintain it.

Unlike FM repeaters, which can be installed by an individual or a club for the benefit of many, a packet radio network is beyond the financial capabilities of the lone ham or even a small group. To stretch data from coast to coast, or even several hundreds of miles across barren terrain demands the expertise of the RF expert, the money of a substantial organization, and the unanimity of all concerned. As a link from one point to another, a gateway station or network controller must be reliable and have the sustaining support of a group large enough to ensure continuity.

With the start of PACSAT development near, now may be the best time to start thinking about how packet activity to the satellite will be handled. It's quite obviously a problem beyond the scope of an individual and requires radio amateurs to once again band together to pool financial and technical resources. The committees and councils formed for the purpose should have a clear understanding of the importance of their work, the short time left to accomplish it, and the absolute need for cooperation, both on the local and regional levels, and also on the national scene.

To prepare for the arrival of spaceborne communications, perhaps the newly formed packet committees should undertake a study of how terrestrial communications can be improved. How wide an area should each committee encompass? Who should deal with the interconnect needs of packet committees in adjacent geographic areas? What types of networks should be established and who should be required to pay for the equipment? Those are some of the questions that face the new committees but they are certainly not all. Some of the stickiest problems will be those that others before have had to deal with, albeit in a different context. For example, can an amateur radio group be truly democratic? That is, should the majority rule on questions of standards and protocols or should such matters be totally within the province of the technical and operations leaders? If money is collected, how should it be spent and for whose benefit? If a digipeater is built, should it be on 220 MHz where it would help populate an as yet underused band, or should it be available to the larger group of users on the 2-meter band?

As you can see, there are many problems to think about and many solutions to be found. Before amateur radio embarks on this grand project to connect the world with digital communications, shouldn't we all think a bit about what directions we should take here on the ground? Like the troika, packet committees will have to pull together in one direction to accomplish their goals.

Harold Winard, KB2M

Starting Out: A Beginner's Guide

by Andy MacAllister, WA5ZIB*

Tracking AMSAT-OSCAR-10 and the low-orbit satellites is a simple task with the help of a number of aids ranging from inexpensive mechanical plotting devices to completely automated, computer-driven rotator systems. Each system has its advantages and disadvantages, in terms of cost, function, and complexity. The right one for you will depend as much on your preferences and needs as on the status of your checking account. I'll describe the options available to you so you can make an appropriate choice.

For many years, manual tracking aids have been the primary tools used by satellite chasers to keep tabs on OSCAR and Radio Sport satellites. Those aids usually consist of a polar projection map and some clear overlays imprinted with signal-acquisition circles and satellite ground tracks. An acquisition circle shows the maximum range of the satellite and thus its accessibility to a ground station. The ground track shows the path of the satellite projected over the earth's surface. Together, they provide a graphic means of finding usable passes and give information for accurately orienting antennas towards the passing satellite. With the help of an orbital calendar, such as those available from Project OSCAR (P.O. Box 1136, Los Altos, CA 94022), the times and longitudes of ascending equatorial crossings can be determined. Used in conjunction with the manual tracking aid, the information quickly gives you the passes that will be in range of your station and the times that a satellite will be above your horizon.

Manual tracking works quite well for low-orbiting satellites, such as the RS series, and permits you to visualize the path of a satellite as it travels around the earth. With some modifications, those aids can be adapted for use with AMSAT-OSCAR-10. But tracking satellites that are in high elliptical orbits can be difficult. Because the orbital altitude is no longer constant, and due to other orbital characteristics, the ground track is continually changing. Thus a new overlay is required every six weeks or so.

Manual tracking aids can be built or purchased. The American Radio Relay League sells its OSCARLOCATOR package and ZRO Technical Devices (P.O. Box 11, Endicott, NY 13760) markets a device called the Satellipse. Instructions on how to put together and use a manual tracking system can be found in "The Satellite Experimenter's Handbook" by Martin R. Davidoff, K2UBC, (available from AMSAT).

The cost of a manual tracking aid is minimal and preparing it for a pass requires little time. However, some effort is required to keep up with the latest equator-crossing information. In the case of AMSAT-OSCAR-10, new ground track overlays would be required periodically.

Because they have become relatively inexpensive, the home computer has become an increasingly popular tool for keeping track of amateur satellites. With a good tracking program and a printer, it is possible to make accurate predictions and generate a detailed plot for weeks or even months into the future. Even a Timex-Sinclair 1000, a modest computer with 16-kbytes of RAM, can nicely handle the computations needed to know the whereabouts of several satellites. At the high end, an IBM Personal Computer with appropriate software can provide real-time graphics presentations of several satellites set against a world map.

There are several sources of satellite tracking software and a good place to start is at the AMSAT Software Exchange (P.O. Box 27, Washington, DC 20044, (301) 589-6062). They have several versions of the popular W3IWI orbital prediction program for many of the most popular home computers.

The advantages of computer tracking are speed and precision. Data is presented in a tabular or graphical format. If a printer is available, the computer can generate a print-out that can serve for many weeks, until the information becomes outdated. Making a printed listing beforehand can be convenient, especially if the computer generates enough RF noise to interfere with satellite reception, particularly on 10 meters.

The ultimate tracking system is one that automatically finds a satellite and then aims the antennas for you. Such a system uses special interface circuitry to tie the computer to the antenna rotator. Of course, specialized software is also needed to determine antenna orientation and keep them aimed at the predicted satellite position.

An automatic satellite rotator is certainly not a project for the beginner or for many an experienced hand. But at one time or another all active satellite chasers dream of such an ideal system. Software is available from AMSAT for the Apple II computer and the necessary interfacing circuits are described in *Orbit* magazine, No. 11. Although there are few sources for automatic antenna software and even fewer for hardware, the cost of such systems is bound to drop. It would be wise to watch for articles and advertisements for those hands-off tracking aids.

If you already own a computer, or have access to one, your best bet is to get a satellite tracking program. If computers are not for you, you can do quite nicely with a manual tracking device to keep you pointed in the right direction. Remember that the art of satellite tracking is not difficult to learn and can help you make many contacts via the highest repeaters around.

*2310 Romayor Court
Pearland, TX 77581

The Digital Front

by Harold Price, NK6K*

As previously alluded to, this technical column will occasionally stray beyond the bounds of the pure engineering domain. Some people feel that is a blatant attempt to sneak in the hard parts, like hiding your dog's worm pill in a piece of steak. They are the same kind of people who ask why there are no restrooms on the Starship Enterprise. Ignore them.

Ask not what AMSAT can do for your Department.

One of the best sources of income for AMSAT over the last year has been the software exchange. For a very reasonable donation at hamfests or through the mail, the AMSAT Software Exchange offers orbit prediction software for most of the popular computers. Most of those packages are based on the original W3IWI efforts of several years ago.

Aside from new versions of prediction software for the endless stream of incompatible home computers (although I haven't seen one with icons for the Macintosh), no really new applications have come by. A few examples of programs I've wished for are:

A Super Track Program—Running in real time, it simultaneously displays the latitude, longitude, and time to the next AOS (acquisition of signal) for all satellites of interest. For satellites currently in range, the azimuth, elevation, Doppler, and phase information are also displayed. Obviously, that is beyond the scope of a Timex-Sinclair or VIC-20, but a large number of hams are upgrading or already have higher-end machines, such as the Apple, Mac, Kaypro, IBM PC, and a host of clones.

Super Track with Graphics—Add a small data base with enough points to get a reasonable outline of the continents. Larger machines can have political boundaries, islands, large lakes, etc. The satellite's track, coverage area, and user's range circle are displayed. The program is written in something portable, such as the C, BASIC, or Pascal languages. Hooks are provided for the graphics driver, for example a single subroutine is called with starting point, ending point, and color of the line to draw. A very simple driver can then be provided for each specific machine/graphics board combination.

Frequency Control—Many satellite users have equipment that can be frequency controlled by computer. Automatic frequency tracking is useful for low-orbit satellites where Doppler tracking is a must. It is also useful for Phase III satellites, where a transmitter that was slaved to the receive frequency would cut down on accidental QRM, whistlers, and the ubiquitous "Hellllllllooo. . . . . hellllloooooo." We need the software, as well as a hardware interface for the more common radios.

There are several more simple tasks that need doing. How about a system that allows you to key in a receive frequency and get back the transmit frequency, corrected for Doppler shift? Or, perhaps, a program that computes the best time for a contact by using your location and the location of someone with whom you wish to arrange a schedule. Such a program must take into account the standard mutual visibility aspects, as well as transponder on/off times, spacecraft attitude (antenna off-pointing), and the look angles of both stations. That would also be handy for scheduling bulletins intended for particular listening areas.

Another very simple program would accept some sort of location, or QTH indicator—such as the latitude and longitude, the callsign prefix, the grid square, or country name—and return the current time of day at the QTH.

Another category is telemetry decoders. The telemetry from UoSAT-OSCARSs 9 and 11 is very interesting to watch, especially the so-called whole-orbit dumps. Such data is a high resolution look at selected values, stored in the onboard computer during an entire orbit and then dumped during succeeding orbits. Usually all the data can be received in one pass. The ultimate test of your software, hardware, and space savvy comes when you accurately predict which side of the spacecraft will be the first exposed to the sun when the satellite comes out of eclipse. The telemetry is easily acquired by a 2-meter FM receiver and a $25 surplus Bell 202-style modem. Software to convert raw data into engineering units, such as volts, milliamperes, and degrees Celsius, would be a most welcome addition to the AMSAT Software Exchange library.

AMSAT-OSCAR-10 telemetry is also available. A snapshot of selected values is transmitted during the RTTY portion of the beacon and continuously updated telemetry is sent during the PSK portion. Special modems are required for the PSK data, but that will be addressed in a future "Where's the hardware" column. Once again, we need software to convert the raw data to engineering values.

Isn't this all a little far-fetched, you ask? I have seen all of those programs, or smaller versions that would make a good base for expansion, running on several machines and written by several programmers. All that is needed is taking that extra step to ensure portability. There is also the small matter of documentation. Then wrap it up and send it in.

If, on the other hand, you said "I've done that!" to any of the above, clean it up and send it in! There are several ways to help out the amateur space program. The next time you are wondering how YOU can help, consider donating software to the AMSAT Software Exchange. It's a gift that will keep on giving.

The UoSAT-OSCAR 11 Digital Communications Experiment—Flying High

Readers of *Satellite Journal*'s predecessor, *Orbit*, have seen an article I wrote about the trials and tribulations of preparing the Digital Communications Experiment for launch. To jump-start your memory,

the DCE is a Z80 microprocessor-based, 126-kbyte computer with two serial ports. It was carried as one of several experiments on UoSAT-OSCAR-11 when that satellite was launched in March 1984 from the Vandenburg Air Force Base in California. The package runs on 5 V and draws less than 150 mA. As we used to say when I was a kid, it's pretty neat.

The DCE was developed at a breakneck pace in Tucson, Dallas, Los Angeles, and Ottawa during late 1983. Part of its development required me to travel to Ottawa in January. In the article, I described Ottawa's weather in less than glowing terms. In fact, the only things glowing were the tips of my ears. At the time, there was 6 feet of snow, and the temperature was almost the same in Fahrenheit as in centigrade.

As an aside to my southern California readers, snow is different beyond our borders. For one thing, it is rumored to fall from the sky by some sort of spontaneous-generation, rather than from the end of nozzles, as on Snow Summit. For another, people have no intention of skiing on the stuff anyway. They leave it lying around in the streets, their yards, anywhere.

For revenge, this past January, Larry Kayser, WA3ZIA/VE3, and Hugh Pett, VE3FLL, both of Ottawa, arranged to be sent to Honolulu. They went there to attend the Pacific Telecommunication's Conference where they planned to conduct a demonstration of store-and-forward message-handling by a low-earth-orbit satellite. During their stay in Hawaii, Larry and Hugh transmitted several messages to UO-11, which were stored and retrieved later at the University of Surrey's command station and also at the Los Angeles DCE control station. Both stations responded to those messages, which were later downlinked in Hawaii.

An earlier low-orbit OSCAR had a limited message relay facility, namely storing and retransmitting a short CW message. And OSCAR-10 has several message buffers for bulletins and command station coordination. Nevertheless, the OSCAR-11 demonstration was still a first. It was a preliminary demo of a device whose primary purpose is to act as a store-and-forward message relay at a higher speed (120 characters/s) and higher bulk (126,000 characters) than any previous amateur satellite. It is the first step toward making low-orbit store-and-forward messaging available to amateur radio operators .

The primary advantage of storing messages on a low-orbit spacecraft, instead of real-time relay through an OSCAR-10-type spacecraft is one of guaranteed delivery in a minimum of time. The polar orbit of UO-11 brings it over every point on the earth several times daily. Messages can be transferred between any two points on earth with a maximum delay of less than 12 hours. With OSCAR-10, two areas can be out of touch with each other for several days at a time. Comparing a low-orbit store-and-forward device with OSCAR-10 is an apples-and-oranges comparison. Each has something it does best. For example, the amount of data that can be moved during an 8-hour OSCAR-10 pass is staggering by current amateur standards. At 1200 bauds, even assuming only 30% efficiency, 1,036,800 characters can be transferred. However, for the next several days I can only move data to the east; New Zealand is out of view. More discussion on this bent will appear in future columns.

While the DCE is a large jump beyond the capabilities of previous amateur store-and-forward devices, it is a mere shadow of the capabilities planned for PACSAT. PACSAT (PACket radio SATellite) will have 40 times the information storage capacity and 16 times the data transmission capability of the DCE. The DCE's purpose is to allow pre-PACSAT experimentation with the hardware, software, and procedures necessary to effectively use that new mode of communications.

The next few months of the DCE's time will be devoted to checkout of the hardware and testing of various messaging and protocol software. One of the primary DCE goals is to watch closely as the hardware "ages" in space. Many of the high-density memory and logic devices in the DCE have not been flown before by amateurs. They must continue to perform well to allow their use in PACSAT, a requirement if PACSAT is to meet cost and performance goals.

In the future, the DCE should allow regular message exchanges between any amateurs, anywhere. Through the use of gateway stations, amateurs can post messages using terrestrial packet systems and the standard amateur packet protocol. The gateway station will store the message for later transmission and retrieval via the UO-11 DCE. Gateway stations will be established in several places around the world. Some already exist in the U.K. and on the North American east and west coasts. Another station will soon be brought up at ZL1AOX in New Zealand. More will be added in the coming months.

Gateway stations are necessary for UO-11 due to its relatively limited data transfer capabililty and because the DCE is only one among many interesting experiments aboard UO-11. Effective use of the DCE will require close coordination among a small group of ground stations. In contrast, PACSAT will have a single mission, and enough capacity to allow direct access by any suitably equipped ground station.

This column will continue to track the progress of the UO-11 DCE and the PACSAT project. Another way to keep in touch is to monitor the information bulletins on UO-9 each weekend, and to watch UO-11's downlink for interesting events.

The Last Paragraph

If you look closely at the last paragraph in most magazine articles, even in pure-fact news, you'll find the author making comments about what has been said, adding non sequiturs, or making predictions. TV reporters are notorious for it. The last paragraph can usually be ignored, as most of us can draw our own conclusions. Most local newspaper editors replace the last paragraphs of wire-service stories with advertising. To save you the trouble of skipping over it, this column will scrupulously avoid inclusion of a last paragraph.

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Worldwide Satellite Operation

by Ray Soifer, W2RS*

Here we are again! Because of the necessary lead-time for publication, this column is being written before the first issue is out; thus I haven't yet heard from readers, so I'll just print what I have, until I get more. As I noted in the last issue, I'd also like to hear from any active satellite operator who might be interested in editing this column, as a guest author, or permanently. Please keep those cards and letters coming!

Driving home one evening, I had a most enjoyable conversation on the Ramapo Mountain ARC repeater (Oakland, NJ) with Hayes Steinhauser, W2DZ. Hayes was originally licensed in 1930, and received his first taste of satellite operation from AMSAT-OSCAR-8. He has been on AMSAT-OSCAR-10 for several months now, and thus far he has made 435 contacts with stations in 70 countries . . . about as many countries as he's worked on the HF bands in 50 years of hamming! Hayes is using an ICOM IC-471A 70-cm transceiver along with a 100-W amplifier and an 18-element crossed Yagi antenna for the uplink. His downlink station consists of a Kenwood TR-9130 2-meter transceiver with a 1-dB noise figure preamplifier in his shack (no wintry climbs to replace burned-out GaAs FET preamplifiers!) and two 14-element crossed Yagi antennas outside. Hayes says that he isn't much for QSL card collecting, awards, etc., but he enjoys talking with so many hams.

Another evening, I had the pleasure of a too-infrequent chat with Bill Leonard, W2SKE, on the TARCOM repeater in Manhattan during one of his occasional stops in New York City. Bill mentioned that he is set up for AMSAT-OSCAR-10 from his home in Washington, DC, and has worked stations in about 35 countries. Like Hayes, he is running 100 W of single-sideband signal but to one crossed Yagi antenna. Bill has worked his old friend Harry Yoneda, JA1ANG, several times via AO-10. They are both trying to get Dick Dorrance, W2LEJ/PP2ZDD, on the air from rural Brazil. Both Bill and Dick are retired from CBS, Bill as president of CBS News, and both attended Dartmouth. Gene Kern, W2BAK, also chimed in from his Tenafly, NJ, home. I had the pleasure of appearing on Gene's old Voice of America show some 25 years ago. Bill, Harry, Dick, and Gene have maintained schedules on the HF bands for many years.

In a recent letter, Pat Gowen, G3IOR, mentions that he is on the AMSAT net frequency, 145.957 MHz, from time to time. I'm sure that all readers join in wishing Pat and his wife, Norma, all the best.

Well, that's it for now. 73, and hope to hear from you soon.

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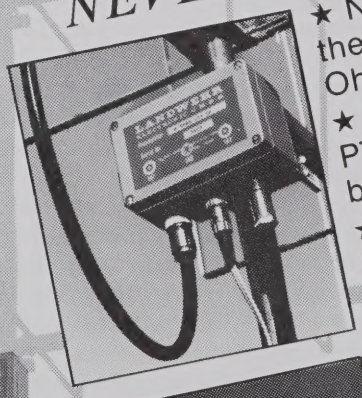

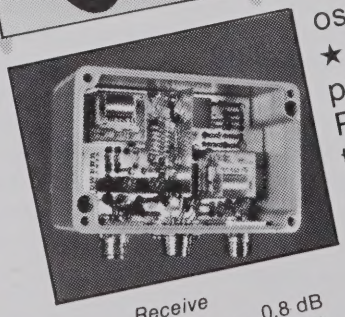

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Calif. residents please call collect on our regular numbers.

W 6 Space Philosopher

by John Browning, W6SP, Chairman of the Board*

In *Orbit* magazine No. 18, I apportioned the history of amateur radio into three eras: the Construction Age, the Assembly Age, and the present Appliance Age. Although that gross oversimplification generated some controversy, I did manage to include one noncontroversial general statement: Everybody agrees that veteran amateurs have settled comfortably into today's world of Appliance Operation, or Systems Engineering, or whatever else one might prefer to call it.

An examination of the AMSAT membership roster clearly supports the premise that senior hams successfully accommodate and actively support our rapid progress into space. As an example, AMSAT Life Member 766 is my Rancho Palos Verdes neighbor, Don Wallace, W6AM. Don was first licensed as 6OC in 1912. He is very well-known for his past and present accomplishments in many aspects of amateur radio operation. He has certainly System Engineered himself an impressive amateur station. From his operating position, Don can switch his feedlines among a complex of nine large, terminated rhombics. The antennas are oriented to permit the pointing of his impressive HF signal on any azimuth, in 20-degree steps, all the way around the compass.

On a personal note, I owe Don a debt of gratitude. His splendid foresight was indirectly responsible for my living and working in my present (next-door) location. It all got started back in the 1940s, when Don employed excellent judgment and considerable bargaining skill to acquire a level plot of 124 hilltop acres at an elevation of 1200 feet on the peninsula that forms the southwest corner of the Los Angeles basin. I can imagine the excitement Don must have experienced as he first walked about his newly acquired "Radio Ranch." As he faced north he could see the beaches of Santa Monica Bay. Turning to his left, he could observe the various Channel Islands to the west, Santa Catalina Island to the south, and to the east, the port community of San Pedro with its adjacent Los Angeles and Long Beach harbors. Throughout his 270-degree panoramic scan, he could look downward at the blue waters of the largest thing on earth, the Pacific Ocean, just two miles away.

On his new "dream" radio site, Don was standing at the center of what had been, only 10,000 years before, an island twin of Santa Catalina. In centuries past, movement of the earth's surface plates had generated great forces that first created the island, then later joined it to the mainland. At the time of the arrival of the first European settlers, the land bridge existed as an extensive marsh that supported a dense growth of slender evergreen trees. Thus, when a Mexican governor awarded the peninsula to the pioneer Sepulveda family in 1834, their land grant was designated "Rancho de los Palos Verdes."

My own first knowledge of the peninsula was garnered while I was a youth in the faraway hills of West Virginia. I received, as a gift, a copy of Richard Henry Dana's classic book, "Two Years Before the Mast." I read and reread Dana's account of his perilous adventures as a seaman aboard the brig Pilgrim, which was engaged in the trade of hides ultimately destined for Boston shoemaking. Among his fascinating descriptions of California in 1835 appears the following: "At San Pedro, there being but one house in the place, there was nothing to see and no company. All the variety that I had was riding, once a week, to the nearest rancho (Sepulveda's) to order a bullock down to the ship." Dana also commented upon another important feature of the area: "I also learned, to my surprise, that the desolate-looking place we were in furnished more hides than any port on the coast. It was the only port for a distance of eighty miles, and about thirty miles in the interior was a fine plane country, filled with herds of cattle, in the center of which was the Pueblo de los Angeles—the largest town in California—and several of the wealthiest missions; to all of which San Pedro was the seaport." With accurate foresight he stated: "In the hands of an enterprising people, what a country this might be, we are ready to say."

During the mid-1960s, Don Wallace yielded to the economic pressures generated by the rapid growth of Southern California. By conveying 100 acres of his plot to a developer, he provided an opportunity for several other amateurs, myself included, to acquire small but superb radio locations. Growth has continued as the new city of Rancho Palos Verdes (population 46,000) recently celebrated its tenth anniversary. The tribulations of local hams in dealing with restrictive antenna ordinances were well chronicled by Wayne Overbeck, N6NB, in an article entitled "PR in Palos Verdes" that appeared in the November 1980 issue of *QST*. Wayne's story is quite complete in almost every respect. However, he did neglect to mention the symbolic name of the very capable lady who has served continuously as the city's first and only planning director, Sharon Hightower. Most of the original cast of characters remain active in amateur and community service. It is gratifying to note that Mel Hughes, K6KSY, and John McTaggert, WD6GBZ, were recently elected to City Council membership. Peter Von Hagen, WA6HXM, serves on the Planning Commission. And we all agree that Rancho Palos Verdes is a great place to live.

Don Wallace's ham shack is now line-of-sight to the homes of almost 10 million "enterprising people" of that "fine plane country." It would have been interesting to observe Richard Henry Dana's reaction if he could have returned to California in November 1983 and listened to the 2-meter band as 10,000 Los Angeles area amateurs simultaneously called Owen Garriott, W5LFL, aboard the spaceship Columbia. He would certainly have heard W6AM in there amongst us!

*Chairman of the Board
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AMSAT NEWS

UoSAT-OSCAR-11 Demos PACSAT Concept

The first demonstrations of store-and-forward packet radio using an amateur radio satellite have been successfully conducted by groups in England, Los Angeles, and Hawaii. The demonstration last January, using UoSAT-OSCAR-11, was part of a proof-of-concept experiment designed to lead to a more capable digital communications satellite called PACSAT.

According to University of Surrey researcher Martin Sweeting, G3YJO, messages were exchanged between WA3ZIA in Hawaii, G3YJO in Surrey, England, and NK6K in Los Angeles. The first successful exchange occurred during the satellite's 2057th orbit since its launch in March 1984.

The historic first messages were downlinked from the satellite using a developmental software package and an on-board module called the Digital Communications Experiment, or DCE. The text of the message was as follows:

"ALL UOSAT TEST MESSAGE"

"ALL UOSAT DCE TEST MESSAGE FROM UNIVERSITY OF SURREY ENGLAND"

"ALL UOSAT These messages are a test of the embryonic store and forward packet radio service on UoSAT-Oscar-11."

"ALL UOSAT The tests are running on the Digital Communications Experiment NSC-800 computer; assisted by the RCA 1802."

"ALL UOSAT They form part of a proof-of-concept demonstration of techniques by AMSAT; VITA; and INTER-PARES at the Pacific Telecommunications Council annual conference in Honolulu, Hawaii this weekend."

"ALL UOSAT The demonstration has been organized by Larry Kayser WA3ZIA; DCE software and support by Hugh Pett VE3FLL and Harold Price NK6K; UoSAT support and groundstation activities by Roger Peel G8NEF and Neville Bean G8NOB."

"ALL UOSAT Thanks are also due to radio amateurs in Hawaii; the Los Angeles area and the Ottawa area for their assistance."

"ALL UOSAT These messages are a test of the embryonic store and forward packet radio service on UoSAT-Oscar-11."

"ALL NK6K DCE message system TEST message; from Redondo Beach; CA."

The message system was a prototype developed specifically by Pett, VE3FLL, for the Hawaii demonstration. The software was uploaded to UO-11 over the weekend preceding the demonstration.

In addition to the DCE team in Canada and the U.S., and the spacecraft controllers at the University

de K2UBC

by Martin R. Davidoff, K2UBC*

If you don't have a first-rate receiving system, operating through AMSAT-OSCAR-10 quickly gets to be a drag. As a sort of corollary, once you have an opportunity to listen to a good receiving setup, you'll never be satisfied with a marginal system.

There are many factors involved in producing a receiving system that provides top performance—a low-noise preamplifier located at the antenna, a good antenna, and attention to a myriad of little details, such as choosing the right connectors and feedline, waterproofing, testing cables for actual loss, and so on. I'll discuss preamplifiers, but I'll give you the conclusion first. Unless you're a masochist, you should be using a GaAs FET preamplifier at the antenna.

Numbers aside, that is, by subjective judgment, most listeners report a phenomenal difference between a 2-dB noise figure preamplifier at the end of 50 ft of coaxial cable and a preamplifier with a 0.5-dB noise figure mounted at the antenna. You've got to hear it to believe it!

Until recently, GaAs FETs were simply too expensive. In addition, there weren't many practical articles describing the construction of 2-meter (Mode B) preamps using the latest devices. As a result, those who wanted a GaAs FET preamp were obliged to lay out from $80 to $130 for a commercial unit. However, recent developments make it possible for the moderately skilled home builder to construct a unit at a fraction of the cost. What developments? First, GaAs FETs, such as the Texas Instruments S3030, are available for $3.50 in single quantities. Secondly, several construction articles have appeared that describe preamps for 2-m and 70-cm using the new, low-cost, dual-gate GaAs FETs. You still can't send in $12.95 for a package of small parts, including a transistor and printed circuit board, but that's one of the reasons I'm writing. Perhaps one of you can take that on as a project. Its potential value to AMSAT is immense.

Let me explain. Back in the Mode-A days, several members kept an extra 10-meter preamp that was constantly on short-term loan

of Surrey, AMSAT members Rick Dittmer, WH6AMX, and Chris Wachs, WA2KDL, were instrumental in the successful demonstration. Dittmer provided support for the Hawaii operation and Chris assisted in ground station activities in Los Angeles.

Volunteers In Technical Assistance, or VITA, a worldwide organization based in the Washington DC area, was elated by the experiment's success. In a news release issued following the demonstration, VITA wrote:

"Using a tiny satellite now orbiting the earth over the poles at an altitude of 429 miles (690 km), a team of technical volunteers from the U.S. and Canada yesterday sent letter-perfect packet radio messages to England from Hawaii, and received replies. The transmissions represent a breakthrough in the use of low orbiting satellites for worldwide communications.

"Introducing the new concept at the Pacific Telecommunications Council's Annual Conference in Hawaii, highly trained technical experts from private voluntary agencies in the U.S. and Canada sent messages to the University of Surrey in Guildford, England, where the satellite (UoSAT-2) was built. The messages—digitized "packets" of information—were stored in the satellite's on-board computer. A few hours later, as the satellite passed over Guildford, the letter-perfect messages were downloaded and printed out automatically by the Surrey ground station's small personal computer.

"Using amateur radio frequencies, inexpensive transmitters and receivers, and personal computers to communicate with a low-orbiting bird, the system that will utilize this technology in the future (already known as PACSAT), will offer telecommunications networking at a fraction of the cost of conventional Telexes. Once operational, the PACSAT system will provide telecommunications ground station equipment, costing not more than $2000 and capable of operating on batteries or solar power, that can be carried in a briefcase. The first full-service PACSAT satellite is scheduled for launch on the shuttle in early 1987.

Spearheading the development of this technology are VITA (Volunteers In Technical Assistance), a private voluntary development agency in Washington, D.C. that specializes in technology transfer; and AMSAT (Radio Amateur Satellite Corp.), an international association of ham radio operators who also design and build satellites. Interpares, a private Canadian agency engaged in community-based development, supports the effort in Canada.

"In Washington, PACSAT International Applications Manager, Dr. Gary Garriott of VITA, said of the contact in space, 'I just wish the people coordinating famine relief in Ethiopia had a PACSAT to communicate with. They could use solar energy to power the radio. It would solve a lot of problems in getting help to those remote places.'"

to someone getting started in satellite communications. Many of those newcomers later became solid AMSAT supporters, in part because of those preamps that let them experience what a good receiving system sounded like.

Let's take a look at the technical information available in several construction articles. In his article "UHF Preamplifier Centers on Budget Dual-Gate FET" (*Microwaves & RF*, Feb. 1984, pp. 141, 143-145), G. Barbari describes a 70-cm unit using a Motorola MRF 966 (about $3.75) or an MRF 967. It provides full construction information and an excellent technical discussion of input and output matching.

In "A 2-Meter Preamplifier Using the TI S3030 Dual-Gate GaAs FET" (*QEX*, Dec. 1984, pp. 8-9, 11), Kent Britain, WA5VJB, focuses on the low-cost part from Texas Instruments. If there's interest, we can reproduce that article in *Satellite Journal*.

Joe Reisert, W1JR, describes a preamplifier for 2 m, 1.3 m, and 70 cm in his column "VHF/UHF World" (*Ham Radio*, Dec. 1984, pp. 99, 101, 103-106, 108, 111-112). The circuit was tested with a variety of transistors, several of which sell for $5 or less. Reisert's article, as usual, is exemplary because in it he discusses, in detail, the trade-offs involved in the major design decisions and the rationale for the elections. Construction information is provided for a unit that uses a broadband output circuit. To change bands, one need only select the correct input inductor and adjust two capacitors.

With the wealth of information available, what else is there remaining to accomplish? Plenty—there are still several practical engineering questions that should be addressed. The first is the question of adjusting a preamp for minimum noise figure. The great majority of amateurs do not own or have ready access to equipment for measuring or minimizing noise figure (NF). Tuning for maximum gain at the frequency of interest can't be depended upon to provide good results. Reisert reports a NF of 1.4 dB in the 2-meter preamplifier when tuning for maximum gain and 0.5 dB when adjusting for a minimum NF. Barbari describes a NF of 0.6 dB when tuning for maximum gain and 0.5 dB when the preamp was set for a minimum NF. Most operators would consider the latter acceptable, but not the former. That points out the major problem that we must face—Is it possible to design a GaAs FET preamp that the home constructor, without access to a noise-figure meter, can adjust for near optimum performance?

I'll have the answer to that and more in the next issue.

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Minutes of AMSAT BoD Meeting

The meeting of the AMSAT Board of Directors was convened at 8:30 AM on November 16, 1984 at the Amfac Hotel in Los Angeles, California with the following present: John Browning, W6SP, John Champa, K8OCL, Tom Clark, W3IWI, John Henry, VE2VQ, Phil Karn, KA9Q, Jan King, W3GEY, Bill Lazzaro, N2CF, Harold Price, NK6K, John Pronko, W6XN, Vern Riportella, WA2LQQ, Martha Saragovitz, Jack Somers, WA6VGS, Martin Sweeting, G3YJO, Harold Winard, KB2M

The Board prepared a comprehensive list of volunteers to be commended for their significant contributions to AMSAT activities:

UOSAT B Battery Development Team:
Stan Kazmiruk, VE3JBA
Dick Atkinson, VE3JBO
Gord Scale
Bob Gillies, VE3JA

DCE RAMUNIT and Construction:
Geoff Clarke, VA3JBD
Dale Ward
George Roach, VE3BNO
Grant Bechthold, VE3JBF
John Henry, VE2VQ
Ron Archer, VE3CNM
Murry Gold, VE3KHG
Larry Kayser, WA3ZIA

DCE CPU and General Memory Design, layout, prototype construction and software:
Dave Cheek, WA5MWD
Chuck Green, NØADI
Lyle Johnson, WA7GXD
Harold Price, NK6K
Bill Reed, WDØETZ
Jose Sancho, WB5YFU
Bob Stricklin, N5BRG

Launch/NASA Coordination:
Dick Daniels, W4PUJ
Tom Clark, W3IWI
Mario Acuna, LU9HBG/W3

MARCE:
Ed Stluka, W4QAU

ASECS:
Dave Eanes, N4AZI

PAST AMSAT Director:
Pat Gowen G3IOR

Former Treasurer:
Jack Colson W3TMZ

Phase 3 Manual Team:
Dom Mallozzi, N1DM
Rich Zwirko, K1HTV
Kaz Deskur, K2ZRO
Jan King, W3GEY
Tom Clark, W3IWI
Dale Covington, K4GSX
Bob Ruedisueli, W4OWA
Bill Hickey, WA5FXE
Doug Loughmiller, KO5I
Rick Dittmer, WH6AMX
Wray Dudley, W8GQW
Greg Roberts, ZS1BI
Dick Peacock, W2GFF

John Champa opened the discussion on whether officers other than those stated in the AMSAT bylaws should be appointed by the Board. It was then moved by John Pronko that the Board only appoint positions stated in the bylaws. The motion passed, 6-0 with one absent.

The role of the President over the last year was discussed by Tom Clark. It was a most difficult year due to work commitments. That, accompanied by feelings of isolation and lack of support from certain BoD members and officers, has prompted Tom to withdraw from the management side of the organization and move over to the technical area.

On a motion of John Browning, the following resolution was adopted (5-0, 1 absent, 1 abstention)
Whereas Tom Clark contributed years of devotion and creativity during his tenure as President, the Board of Directors of AMSAT commends Mr. Clark and extends its deep appreciation.

The Board then voted to elect the following officers:
Board Chairman—John Browning, W6SP
Corporate Secretary—Martha Saragovitz
Treasurer—Art Feller, KB4ZJ

At this time, John Henry moved that the next Board of Directors meeting be held no later than March 1985. That motion was carried 6-0 with 1 absent.

A request by the Board of Directors that the President submit to the Board a concise operational plan describing the proposed management of AMSAT activities passed with 5 in favor, 1 opposed and 1 absent.

Continuing with the election of officers:
President—Vern Riportella, WA2LQQ
Executive Vice President—John Champa, K8OCL
Vice President Engineering—Jan King, W3GEY
Vice President Operations—John Champa, K8OCL will assume this position in a temporary capacity until the position can be better defined and an appropriate individual identified.

Financial Status Report

Bill Lazzaro presented a financial statement and new member reports. It was noted that there was a 36% increase in membership for the 12 month period.

Jan King expressed the need for $50,000 for the next two years to support our share of Phase 3C. In addition, PACSAT should be given substantial support. A look at the proposed 1985 budget showed projects deriving 32% of the total budget.

Discussion followed on Volunteer Services. Dick Jansson, WD4FAB with the use of a comprehensive survey form has identified interested individuals. With the use of this form, he has matched these individuals with new and existing projects. The Board requested that officers and others who need personnel receive periodic updates of the survey form.

Technical Review

Jan King reviewed the AMSAT International Technical Meeting that took place in Cheltenham, England on June 30th, 1984.

At that time, each group that was present reported on their current and future projects. Discussion on international projects took place and the formation of an international Amateur Satellite Service Coordinating Committee was proposed. The group recognized that:

1. The launch of a satellite system represents the creation of a significant resource for the use of all radio amateurs;
2. That the mission requirements of the groups providing a new satellite system are of primary importance;
3. That the operational aspects of the amateur satellite service must be carefully identified, planned and managed; and
4. That the freedom of the individual national and international groups to negotiate and plan new missions independent of external constrants must be maintained.

The mandate of the Committee shall be to:

1. Establish technical and operational standards for the amateur satellite service;
2. Plan and coordinate the orbital operations of each portion of a system that may be released by the groups which launched the system; and
3. Interface with the IARU to ensure that the best interests of all radio amateurs are given due consideration in this planning process.

It was further proposed that membership of the Committee be limited to those groups who have as a primary interest the provision and utilization of amateur satellite services, as evidenced by their constitutions or charters, and to such further groups as the committee shall determine.

On the subject of Phase 4, the group felt it required further thinking as far as fund-raising and the ability of the group to handle the entire technical area.

At this time, Tom Clark moved that the Board support the Cheltenham resolution and agree to participate at the first opportunity in forming the Committee. This passed 6-0 with 1 absent.

Work on Phase 3C will begin in Washington, DC, January, 1985. The mechanical group headed by W4PUJ will work on the spacecraft structure for the first 3 months of 1985. The spacecraft will then be shipped to Colorado for integration (9-10 months). Thermal vaccum and vibration tests are planned for Colorado. The spacecraft will then be transferred to Marburg, West Germany. Phase 3C is scheduled for a mid-1986 launch aboard Ariane 4.

A status report on PACSAT was given by Harold Price. Target date for launch is early

1987 on the second shuttle at Vandenburg. The launch will have a 57-degree inclination. Tom moved that AMSAT support the PACSAT project and that the PACSAT Project Manager and the General Manager are instructed to work out resource requirements for the project. The motion carried with 4 in favor and 3 absent.

Jan King expressed the need for the Board to establish long-range goals. After much discussion the Board voted 6-0 (1 absent) to implement the following goals:

1. Recognizing the relative abundance of low-earth-orbit launch opportunities and their particular relevance to communications store-and-forward techniques on a world-wide basis, AMSAT will strive to make effective use of low-cost spacecraft technology to exploit such opportunities.

2. Recognizing the potential value and utility of continuous satellite communications to provide effective public services, AMSAT will strive to develop space systems to fulfill this need.

3. Recognizing the growing value of space science and space research activities to our organization, AMSAT will strive to participate and cooperate with other organizations in pursuing appropriate space science and research activities.

4. Recognizing the value of the communications services provided by the Phase 3 satellite program, AMSAT will continue to support the program.

Operations

John Champa reviewed the status of the Area Coordinators Program. A survey was conducted to see who was willing to continue to serve and who wished to leave.

Other areas of interest reported on by John:

1. AMSAT Management Conference—This is to be held in Chillicothe, OH for the Ohio field organization. Others who are interested are encouraged to attend. Items discussed will be: How the volunteer program operates, recruiting techniques, AMSAT presentations, organizing and staffing an AMSAT booth, how to obtain answers to your questions and how to be a good satellite Elmer.

2. AMSAT Management Bulletin—This will give management and marketing information to the field organization.

3. Nets—The difficulty of getting net controllers was discussed. In addition, we will be looking into greater use of the satellite for nets. It was noted that a Special Temporary Authorization (STA) for 21 people was received from the FCC. The authorization is for 180 days and it is for operating gateways via satellites.

4. CCIR—The need to update the CCIR was expressed. John will ask Martin Davidoff to help on this project.

Tom Clark moved that the Board thank the ARRL for adopting a position of leadership and support in obtaining WARC-79 frequency allocations and that we endorse their action to put WARC into force. Jan seconded the motion and it was carried 6-0 with 1 absent.

A lengthy discussion followed on a DXCC award. John Browning proposed that AMSAT support a non-endorsable DXCC Satellite Award pending concurrence of AMSAT-DL. The vote was 3 in favor, 1 opposed, 1 abstention and 1 absent.

Other projects that still needed work were: The AMSAT Satellite Emergency Communications Systems; revision of the Space Communications chapter of the 1986 ARRL Handbook and the Amateur Space Program brochure.

After a close look at a draft copy of the Phase 3 Manual, the Board directed the General Manager and officers to work on getting it into the hands of the public.

Publications

Bill Lazzaro suggested that based on the results of the membership survey, *Orbit* magazine should change its format. All present agreed and a Board resolution was passed stating that a publication, semi-glossy, two-tone cover, saddle stitched stressing production economy be published on a regular basis containing a wide spectrum of items. This new publication will be printed in Washington, DC.

In order to raise money for satellite construction, Harold Winard proposed that the Board consider sale of the AMSAT mailing list. Concern was expressed by some for those members who might find this objectionable. Tom then moved that the Board accept Harold's recommendation subject to review after the polling of the membership. The vote was 3 in favor, 1 abstention, 3 absent.

Bill Lazzaro expressed the need to establish a Board of Trustees whose purpose would be to help raise funds for AMSAT. The Board accepted this concept and empowered the General Manager to study the issue further and report back to the Board by the next meeting (4 in favor, 3 absent).

The last item to be voted on was the proposed 1985 budget. This was passed with a vote of 4 in favor and 3 absent.

The Board of Directors Meeting closed at 6:10 PM.

Respectfully Submitted,

Martha Saragovitz
Corporate Secretary

Orbital Elements

Satellite: rs-3

Catalog number:	12997	
Epoch time:	85010.44191399	
	Thu Jan 10 10:36:21.368	1985 UTC
Element set:	111	
Inclination:	82.9600	deg
RA of node:	18.1490	deg
Eccentricity:	0.0057519	
Arg of perigee:	274.3803	deg
Mean anomaly:	85.0694	deg
Mean motion:	12.15589082	rev./day
Decay rate:	4e-08	rev/day^2
Epoch rev:	13608	
Semi major axis:	7987.322	km
Anom period:	118.461084	min
Apogee:	1676.060	km
Perigee:	1584.176	km
Ref perigee:	2566.42247454	
	Thu Jan 10 10:08:21.799	1985 UTC

Satellite: rs-4

Catalog number:	13000	
Epoch time:	85013.24262915	
	Sun Jan 13 05:49:23.158	1985 UTC
Element set:	243	
Inclination:	82.9608	deg
RA of node:	27.3674	deg
Eccentricity:	0.0018374	
Arg of perigee:	4.6513	deg
Mean anomaly:	355.4740	deg
Mean motion:	12.06665063	rev/day
Decay rate:	4e-08	rev/day^2
Epoch rev:	13542	
Semi major axis:	8026.680	km
Anom period:	119.337175	min
Apogee:	1663.422	km
Perigee:	1633.925	km
Ref perigee:	2569.24367105	
	Sun Jan 13 05:50:53.178	1985 UTC

Satellite: rs-5

Catalog number:	12999	
Epoch time:	85011.51152324	
	Fri Jan 11 12:16:35.607	1985 UTC
Element set:	213	
Inclination:	82.9603	deg
RA of node:	30.0751	deg
Eccentricity:	0.0011067	
Arg of perigee:	37.2341	deg
Mean anomaly:	322.9488	deg
Mean motion:	12.05055821	rev/day
Decay rate:	4e-08	rev/day^2
Epoch rev:	13503	
Semi major axis:	8033.829	km
Anom period:	119.496539	min
Apogee:	1672.287	km
Perigee:	1654.505	km
Ref perigee:	2567.52006392	
	Fri Jan 11 12:28:53.522	1985 UTC

Satellite: rs-6

Catalog number:	13002	
Epoch time:	84363.55338691	
	Fri Dec 28 13:16:52.629	1984 UTC
Element set:	94	

Inclination:	82.9626	deg
RA of node:	27.7035	deg
Eccentricity:	0.0049409	
Arg of perigee:	322.4305	deg
Mean anomaly:	37.3313	deg
Mean motion:	12.13563287	rev/day
Decay rate:	4e-08	rev/day^2
Epoch rev:	13429	
Semi major axis:	7996.214	km
Anom period:	118.658830	min
Apogee:	1665.408	km
Perigee:	1586.391	km
Ref perigee:	2553.54484199	
Fri Dec 28	13:04:34.347	1984 UTC

Satellite: rs-7

Catalog number:	13001	
Epoch time:	85011.04263653	
Fri Jan 11	01:01:23.796	1985 UTC
Element set:	187	
Inclination:	82.9625	deg
RA of node:	25.9799	deg
Eccentricity:	0.0021046	
Arg of perigee:	323.5774	deg
Mean anomaly:	36.3886	deg
Mean motion:	12.08691835	rev./day
Decay rate:	4e-08	rev/day^2
Epoch rev:	13538	
Semi major axis:	8017.699	km
Anom period:	119.137067	min
Apogee:	1663.854	km
Perigee:	1630.106	km
Ref perigee:	2567.03427382	
Fri Jan 11	00:49:21.257	1985 UTC

Satellite: rs-8

Catalog number:	12998	
Epoch time:	85013.47486657	
Sun Jan 13	11:23:48.471	1985 UTC
Element set:	307	
Inclination:	82.9592	deg
RA of node:	31.3956	deg
Eccentricity:	0.0020341	
Arg of perigee:	82.0398	deg
Mean anomaly:	278.2961	deg
Mean motion:	12.02952993	rev/day
Decay rate:	4e-08	rev/day^2
Epoch rev:	13508	
Semi major axis:	8043.195	km
Anom period:	119.705426	min
Apogee:	1702.071	km
Perigee:	1669.349	km
Ref perigee:	2569.49373308	
Sun Jan 13	11:50:58.538	1985 UTC

Satellite: oscar-9

Catalog number:	12888	
Epoch time:	85012.11367226	
Sat Jan 12	02:43:41.283	1985 UTC
Element set:	722	
Inclination:	97.6157	deg
RA of node:	356.3947	deg
Eccentricity:	0.0004374	
Arg of perigee:	93.7985	deg
Mean anomaly:	266.3795	deg
Mean motion:	15.26859903	rev./day
Decay rate:	1.443e-05	rev/day^2
Epoch rev:	18141	
Semi major axis:	6860.308	km
Anom period:	94.311207	min
Apogee:	506.081	km
Perigee:	500.080	km
Ref perigee:	2568.13070440	
Sat Jan 12	03:08:12.860	1985 UTC
Beacon:	145.8250	MHz

Satellite: oscar-10

Catalog number:	14129	
Epoch time:	85010.63929339	
Thu Jan 10	15:20:34.948	1985 UTC
Element set:	155	
Inclination:	25.9805	deg
RA of node:	158.8441	deg
Eccentricity:	0.6009837	
Arg of perigee:	338.5687	deg
Mean anomaly:	4.2684	deg
Mean motion:	2.05855838	rev./day
Decay rate:	−5.5e-07	rev/day^2
Epoch rev:	1188	
Semi major axis:	26105.528	km
Anom period:	699.518660	min
Apogee:	35416.928	km
Perigee:	4038.934	km
Ref perigee:	2566.63353370	
Thu Jan 10	15:12:17.311	1985 UTC
Beacon:	145.8100	MHz

Satellite: oscar-11

Catalog number:	14781	
Epoch time:	85009.61342034	
Wed Jan 9	14:43:19.517	1985 UTC
Element set:	53	
Inclination:	98.2154	deg
RA of node:	76.9032	deg
Eccentricity:	0.0014001	
Arg of perigee:	6.7366	deg
Mean anomaly:	353.4033	deg
Mean motion:	14.61937166	rev./day
Decay rate:	6.2e-07	rev/day^2
Epoch rev:	4586	
Semi major axis:	7062.142	km
Anom period:	98.499445	min
Apogee:	694.173	km
Perigee:	674.398	km
Ref perigee:	2565.61467376	
Wed Jan 9	14:45:07.812	1985 UTC
Beacon:	145.8260	MHz

Satellite: noaa-7

Catalog number:	12553	
Epoch time:	85012.89098361	
Sat Jan 12	21:23:00.983	1985 UTC
Element set:	303	
Inclination:	99.0762	deg
RA of node:	352.8286	deg
Eccentricity:	0.0012235	
Arg of perigee:	223.6573	deg
Mean anomaly:	136.3631	deg
Mean motion:	14.13132977	rev/day
Decay rate:	1.36e-06	rev/day^2
Epoch rev:	18347	
Semi major axis:	7223.993	km
Anom period:	101.901238	min
Apogee:	864.625	km
Perigee:	846.947	km
Ref perigee:	2568.86417889	
Sat Jan 12	20:44:25.55	1985 UTC
Beacon:	137.6200	MHz

Satellite: noaa-8

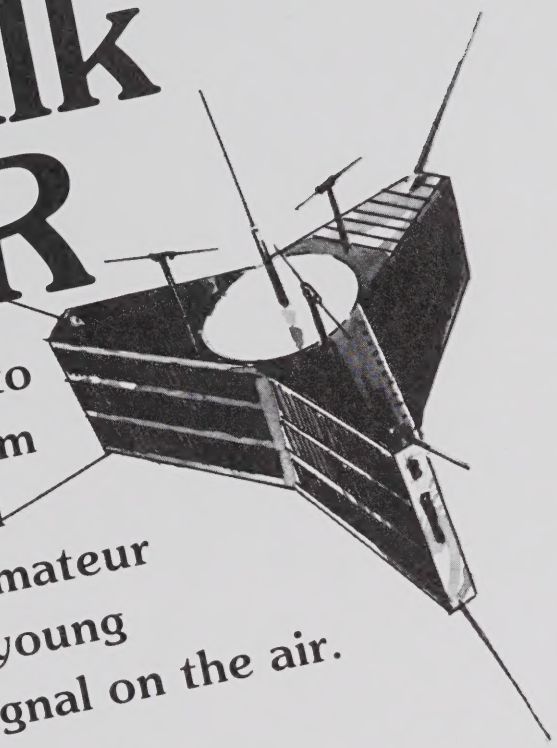
Catalog Number	13923	
Epoch time:	84360.38115977	
Tue Dec 25	09:08:52.204	1984 UTC
Element set:	96	
Inclination:	98.6871	deg
RA of node:	28.8646	deg
Eccentricity:	0.0015940	
Arg of perigee:	218.8020	deg
Mean anomaly:	141.2013	deg
Mean motion:	14.22442937	rev./day
Decay rate:	3.7e-07	rev/day^2
Epoch rev:	9065	
Semi major axis:	7192.394	km
Anom period:	101.234289	min
Apogee:	833.919	km
Perigee:	810.990	km
Ref perigee:	2550.35358567	
Tue Dec 25	08:29:09.801	1984 UTC
Beacon:	137.5000	MHz

Satellite: noaa-9

Catalog number:	15427	
Epoch time:	85002.40499141	
Wed Jan 2	09:43:11.257	1985 UTC
Element set:	11	
Inclination:	98.9258	deg
RA of node:	316.9351	deg
Eccentricity:	0.0014950	
Arg of perigee:	207.6935	deg
Mean anomaly:	152.3436	deg
Mean motion:	14.11354661	rev/day
Decay rate:	6.1e-07	rev/day^2
Epoch rev:	295	
Semi major axis:	7230.057	km
Anom period:	102.029634	min
Apogee:	867.229	km
Perigee:	845.611	km
Ref perigee:	2558.37500769	
Wed Jan 2	09:00:00.664	1985 UTC
Beacon:	137.5000	MHz

Via Phil Karn, KA9Q

We talk OSCAR



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TR-9130

TR-9130 2 meter all mode

The TR-9130 is a compact rig that gives you 25 watts of RF power on all modes!! You can select your tuning steps from 100-Hz, 1-kHz, 5-kHz or 10-kHz. With six memories, you can program your favorite frequencies! (FM 1-5 Simplex or ±600-kHz offset, memory 6 non-standard offset, all six for simplex, any mode!) Dual digital VFO's, and transmit frequency tuning enhance OSCAR operations.

Internal battery back-up (9 V Ni-Cd not Kenwood supplied) retains memories for approximately 24 hours, in case you operate mobile and base!

Other convenient features such as automatic band scan, squelch circuit for FM/SSB/CW, tone switch, repeater reverse switch, CW semi break-in; sidetone, high performance noise blanker HI (25) LOW (5) power switch (FM/CW) RF gain control, and RIT circuit further enhance this expressive package!

Optional accessories:

- KPS-7A AC power supply.
- PS-20 AC power supply (TR-9500 only).
- BO-9A system base with memory back-up supply.
- SP-120 external speaker.
- TK-1 AC adapter for memory back-up.
- SP-40 mobile speaker.
- SP-50 mobile speaker.
- SW-100 A/B power meters.
- MC-55 Mobile Mic w/time-out timer.

TR-9500

70 CM SSB/CW/FM transceiver

- Covers 430-440 MHz, in steps of 100-Hz, 1-kHz, 5-kHz, 25-kHz or 1-MHz.
- CW-FM Hi—10 W, Low—1 W. SSB 10 W.
- Automatic band/memory scan. Search of selected 10-kHz segments on SSB/CW.
- 6 memory channels.

TS-711A/TS-811A

Multi-function all-mode 2 m and 70 cm transceivers.

The TS-711A 2 m (142-149 MHz) and TS-811A 70 cm (430-450 MHz) all-mode transceivers are perfect base station units, designed to complement your present HF station. Both feature Kenwood's innovative D.C.S. circuitry. Built-in dual digital VFO's provide commercial-grade frequency stability through the use of a TCXO (Temperature Compensated Crystal Oscillator). The new fluorescent multi-function display shows frequency, RIT shift, VFO A/B, SPLIT, ALERT, repeater offset, digital code, call sign code, and memory channel. 40 multi-function memories store frequency, mode, repeater offset and tone. They have programmable scan, memory scan, and mode scan. The Auto-mode function automatically selects the correct mode for the frequency being used. When a mode key is depressed, an audible "beeper" announces mode identification in International Morse Code.

The TS-711A/TS-811A also feature all-mode squelch, noise blanker, speech processor (SSB, FM), IF shift, RF power control, alert, and a unique channel Quick-Step tuning that varies tuning characteristics from conventional VFO feel, to stepping action when CH.Q switch is depressed.

Combine all these features with built-in AC power supply and a hefty 25 watts RF output power and you have your ideal base station.

Optional accessories:

- CD-10 Call sign Display
- TU-5 CTCSS Tone Unit • VS-1 Voice Synthesizer • MC-60A Deluxe Desk Mic • MC-80 Desk Mic • MC-85 Desk Mic
- SP-430 External Speakers
- MB-430 Mobile Mount
- PG-2J DC Cable